The Montana is placed inside the safety cage and securely mounted to the roof of the vehicle. Figure 2 shows the Montana system and the external battery mounted on a motor grader. There are two reasons for placing the Montana on the roof of the vehicle. The first is so that the Montana will not interfere with the operation of the vehicle and the second is so that the research team members can have access to the Montana to check its status. The external battery is also located in an area that will not interfere with the operation of the vehicle. Although the vehicle's battery may be used to power the Montana, the research team always used a separate battery to minimize the number of connections to the vehicle's systems. The location of the Montana and the battery varied among different types of vehicles.

After installation on the vehicle, the Montana system must be warmed up for 45 minutes before data collection can begin. If the Montana has been installed properly, it will collect emissions data automatically and autonomously as the construction vehicle operates.

2.3.2.2 Laptop Computer

A second computer that is not part of the Montana system is used to collect and record modes of activity for each construction vehicle. Although the laptop computer is not directly connected to the Montana, it is coordinated with it via the laptop computer's internal clock. Therefore, the modes of activity of the vehicle can be directly correlated to its air pollutant emissions. The clock of the laptop computer is synchronized with the clock of the Montana to provide a second-by-second analysis of the emissions, based on the vehicle's mode of activity. The laptop computer is then ready to record modal activity of the construction vehicle that can now readily be linked to emissions as well as to engine performance.

During the data collection process, the research team follows the construction vehicle at a safe distance without interfering with the vehicle's operation. The objective is to collect modal activity data without interrupting the productivity of the vehicle.

Recording modal activity is accomplished by using the numeric keypad of the laptop computer. Each activity mode of the construction vehicle is linked to a keypad number. For example, the activity modes and their corresponding number for a motor grader are as follows:

1. Idling
2. Moving
3. Blade

Each time the motor grader begins one of these activity modes, the corresponding number is pressed on the numeric keypad. For example, when the motor grader begins to idle, the 1 key is pressed on the keypad; when the motor grader begins to move forward without using the blade, the 2 key is pressed on the keypad; when the motor grader moves while using the blade, the 3 key is pressed on the keypad. Since the time is recorded for each keystroke, the duration of each recorded activity mode can be determined. Both the Montana system and the laptop computer are synchronized to the current time before data collection begins. Furthermore, the emissions data from the Montana system are compared to the modal data from the laptop computer to provide a detailed timeline of emissions activity for the construction vehicle.